"A STUDY IN SUSTAINABLE FORENSICS: HARNESSING BOTANICAL RESOURCES FOR LATENT FINGERPRINT DEVELOPMENT"

RESEARCH PLAN

FOR REGISTRATION IN DOCTOR OF PHILOSOPHY

BY

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CERTIFICATE

This is to certify that this Research proposal entitled **"A STUDY IN SUSTAINABLE FORENSICS: HARNESSING BOTANICAL RESOURCES FOR LATENT FINGERPRINT DEVELOPMENT"** by **Ms. Vaishnavi Hitendra Thakre**, submitted in fulfilment of the requirement in Ph.D. program in **Department of Botany** under School of Sciences of JECRC University, Jaipur, Rajasthan, during the academic year 2024, is a bonafide record of work carried out under our guidance and supervision.

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INTRODUCTION

The science of dactyloscopy has been growing for decades, and therefore efforts are being made in developing various methods for latent print development, lifting, and preserving these impressions. These methods include, physical, chemical, as well as fuming methods (Mishra, 2022). Fingerprints are the impression of friction ridges found on the distal phalanges of the hand. Friction ridges refer to the textured carvings present on the palms of the hands and soles of the feet. These friction ridges are basically for the purpose of firm gripping. If these weren't present, one could not have been able to hold the objects firmly, and they could have slipped. Hence, these are of importance. (Kaushal & Kaushal, 2011).

We first identified fingerprints from the impressions of friction ridge skin found to date. During the Neolithic period, builders left friction ridge impressions in various ancient materials, though it is unclear whether this was intentional. Some artifacts, however, display these ridges carved into them, indicating intentional creation (Ashbaugh, 1999). Examples include Megalithic artwork on the Gavrinis tomb on the west coast of France and a tomb at Newgrange on the coast of Ireland.

Friction ridge skin imprints have been utilized for thousands of years in many different civilizations as a form of identification. Friction ridge skin imprints were utilized in China as early as 300 B.C., Japan as early as 702 A.D., and the US since 1902 to verify an individual's identity. Friction ridge impressions were first employed for identification purposes by the Chinese, according to historical records. ("Fingerprint Sourcebook | National Institute of Justice," n.d.).

Malpighi was the first to use a newly invented microscope for medical studies, observing that ridged skin enhances traction for walking and grasping by increasing friction between the skin and objects. Ghosh et al. (2018). Thereafter, as the field kept growing, fingerprints were accepted worldwide as a means of individualization. Fingerprints are of three basic types based on their nature of occurrence, viz., latent, patent, and plastic prints. (Win et al., 2020) Latent fingerprints are those that are invisible and basically are the negative impressions left unintentionally by an individual at the crime scene or scene of occurrence. (Gomes et al., 2023) Since these are invisible and hence need to be developed for visualization. For example, prints found on the doorknobs, window panes, etc.

Patent fingerprints are the visible prints, which are usually seen in the form of bloody prints or inked prints at the scene of occurrence. These are the results of a condition wherein an individual already has certain liquid material like blood, ink, grease, etc. on his hand and places it onto the surface, resulting in the deposition of the residue in the colored fingerprint form. These prints do not need to be developed but can be enhanced for better visualization. The third type of fingerprint is the plastic print, which refers to the impressions found in 3D form, like in the case of molds, soap or waxy material, etc. (Kapoor et al., 2023). The prints found at the crime scenes are usually referred to as chance prints. These need to be developed for which various techniques such as physical, chemical, and other advanced techniques are used.

The physical method of fingerprint development includes the powder dusting method, fuming by iodine crystals, etc., whereas chemical methods such as ninhydrin, silver nitrate, and cyanoacrylate fuming are utilized. The reaction between cyanoacrylates and latent print residue is quite complex and not fully understood. The range of initiator compounds includes substances such as lactic acid, ammonia, acetic acid, amines, alcohols, amino acids, alkanes, and proteins. (Czekanski et al. 2006; Wargacki et al. 2007; Wargacki et al. 2008).

Apart from this, methods like physical developer, small particle reagent, and metal deposition techniques are also utilized for fingerprint development. (Sodhi & Kaur, 2001) All the above-mentioned methods are the conventional methods of dealing with the fingerprints.

Unconventional approach

The traditional methods are not always effective and pose various drawbacks that the experts are trying to overcome and improve over the years (Kumar, 2017). Using unconventional methods involves using non-traditional materials or techniques to improve the visibility of fingerprints. Over recent years, there has been an increasing trend in developing fingerprints through these unconventional methods. This shift is driven by concerns over the conventional approach, which relies on powders and reagents containing potentially harmful chemical compounds and is also costly. (Harshita et al., 2022) To address these drawbacks, the unconventional method involves using waste materials such as household items and kitchen staples like gram flour (Rai et al., 2024) and coffee, which have proven effective. They are both safe and economical to use. Moreover, adopting this approach promotes ecosystem preservation and sustainability.

Below are images of latent prints developed using unconventional powders by different researchers, demonstrating that selecting the right powder can yield clear prints with visible ridge characteristics.

Print by coriander powder Source: (Dhunna et al., 2018)	Print by rose powder Source: (Godara et al., 2022)	Print by hibiscus powder Source: (Godara et al., 2022)	Print by synthetic food color powder Source: (Kumari et al., 2011)

While the unconventional approach offers more benefits than traditional methods, such as fewer side effects and lower costs, it has a drawback in the limited shelf life of these products. This study aims to use plant-based materials and extracts to develop latent prints in various forms, with a focus on extending their storage life.

FORENSIC SIGNIFICANCE OF STUDY

Fingerprint is one of the crucial types of evidence utilized for individualization. Utilizing unconventional methods in fingerprint development can be significant in forensic investigations for various reasons:

1. Enhanced Detection of Fingerprints on Diverse Surfaces: Fingerprints are sensitive to various residues and surfaces; unconventional approaches have the potential to disclose fingerprints that traditional techniques might overlook.

2. Alternative Solutions for Difficult Surfaces: Developing fingerprints on difficult surfaces using traditional methods might not give best results every time. Here, unconventional methods may prove to be good alternatives to achieve best outcomes.

3. Advancing Eco-Friendly Forensics with Plant-Based Techniques: Utilizing plant- based approach in fingerprint development can be a great leap in achieving self- sustainability thereby reducing use of harmful chemicals which will ultimately contribute in promoting eco-friendly aspect of the environment.

4. Innovative Reagents for Developing Aged Fingerprints: There are limited resources available for developing old prints and hence, experiment on developing reagents and powders utilizing various components may contribute in producing some agents that may help develop old prints effectively.

5. Driving Forensic Innovation: Exploring the arena of unconventional methods definitely drives innovation in the field of forensic science in order to develop new technologies and methods for fingerprint analysis.

6. Forensic Evidence and Legal Approval: The fingerprints developed using unconventional methods are also accepted by the courts as far as the methods are scientifically proven and develops clear impressions that could link the suspect to the crime scene.

LITERATURE REVIEW

The traditional powders use various chemical-based components such as lead, zinc dioxide, mercury, etc., which pose harmful effects on human exposure. Sodhi and Kaur (2001); Rabjerg et al. (1983). The attempt at utilizing unconventional approaches, specifically if the eco-friendly approach is adopted, contributes to minimizing the environmental impact. Since the traditional methods often involve chemicals that are of hazardous nature, posing consequences such as harming ecosystems and human health. Therefore, the proposed study aims at utilizing non-toxic materials in order to promote sustainability in forensic investigations. The attempt to incorporate green practices in preparing the powders and reagents aligns with global efforts to protect the environment, thereby creating a more sustainable future.

In unconventional approaches, the flowers have also been tested to develop prints. In a study done by Godara et al. (2022), the rose and hibiscus petals multicolored powder have been prepared for latent print development, resulting in an exceptional outcome.

In another similar approach, Sagar et al., (2022) utilized three different powders namely Titanium dioxide powder, Arrowroot powder (*Maranta arundinacea*), dried raspberry powder (*Rubus idaeus*) and observed good results and found that the powders remained quite stable.

An eco-friendly approach to develop fingerprints is adopted by Lohar et al., (2022) utilizing natural colors produced by plant-based waste material such as orange and lemon peel powders.

In unconventional approaches, not only seeds, flowers and leaves are used but also barks are proven to be useful. Jaya et al., (2021) attempted latent print development on walls, floors and doors using Lodhra Bark powder wherein the prints were found to be clearly visible.

Arthanari & Shanmugam, (2021) attempted to visualize the latent fingerprint using spirulina powder on electronic surfaces and the attempt proved to be effective.

The interest is seen in using commonly available products such as household stuffs in fingerprint development which are readily available. In one of such similar studies, Nigam et al., (2020) discussed the effectiveness of Talcum Powder for Decipherment of Latent Fingerprints on Various Substrates.

One of the approaches stresses upon use of vegetables for powder development wherein Jamal, (2019) produced beetroot and broccoli powder with no added chemicals which on utilizing, developed clear latent prints.

The studies on utilizing kitchen products have been proven to be of great convenience and use. Various spices readily available in kitchen are used in one of such studies by Dhunna et al., (2018) who tried kitchen king spice powder, coriander powder, garam masala powder, cumin powder, fuller's earth, limestone, turmeric and red chilli powder wherein the result showed a well-developed fingerprint on various surfaces.

Kamble & Bansod, (2018) came up with another approach of using different colored soil for latent print development at the crime scene which proved to be useful as it showed clearly visible prints.

Along with above mentioned stuff, an attempt of utilizing waste material has been made by Sankhla et.al., (2018) who have used the waste marble slurry which is produced in large amount by the marble industry and have obtained clearly developed fingerprints.

Chauhan and Udayakumar, (2017) attempted the development of latent prints using unconventional methods wherein they utilized gram flour, natural henna, vermilion, and coffee powder. The prints developed were found to be clear and identifiable.

The attempt of utilizing seeds in making fingerprint powder has also been proven to be useful in a study done by Zulkifli, (2017). The author utilized Durian seeds powder for fingerprint development as a green and effective approach.

In one of the approaches, Badiye & Kapoor, (2015) have studied the efficacy of Robin powder blue for latent print development on various surfaces which is a commonly available household product.

Another relevant study mentions the use of red chilli powder, Turmeric powder, Marigold flower powder, Black Charcoal powders and Mustard Oil Soot for latent fingerprint development wherein except chilli powder, all the methods proved to be useful in developing clear latent prints as explained by Seerat et.al., (2015).

An attempted has been made by Rohatgi & Kapoor, (2014) in their study that uses several household powders like cocoa powder, custard powder, corn flour, baking soda, baking powder, black salt, edible food (orange color) and turmeric powder which is readily available and simple to use for fingerprint development.

Developing prints on adhesive sides of tapes is one of the challenges in fingerprint development. Hence, in a study done by Jasuja et al., (2007), they have proposed Rose Bengal dye for latent fingerprints is the sticky side of adhesive tapes. This formulation is based on a phase transfer catalyst (PTC) which develops fingerprints on all type of adhesive tapes of such a quality that even third level detail can be seen.

A class of organic base fluorescent powders have been developed by Kerr et.al., (1983) with cornstarch for developing prints on nonporous surfaces and for enhancing the weak prints.

OBJECTIVES OF THE STUDY

1. To search and screen various plant components for their potential in forming fingerprint development powders and formulating small particle reagents, including associated chemical agents.
2. To assess the effectiveness of powders in developing fingerprints on a variety of porous and non-porous surfaces.
3. To assess the effectiveness of small particle reagents in developing fingerprints on a variety of porous and non-porous surfaces.
4. To analyze the chemical, physical, and adhesive properties of the formulated powders and small particle reagents.
5. To recommend protocols for latent fingerprint development using bio-based powders and small particle reagents on both porous and non-porous surfaces, through comparative analysis ensuring accuracy and reliability comparable to conventional methods.

RESEARCH METHODOLOGY

1. The first stage involves selecting and screening plant components with potential for developing powder- and reagent-based methods for latent fingerprint detection. Selection criteria will focus on the plant materials' basic composition and their interaction with sweat and fingerprint residues. The screening process will also evaluate the properties of an ideal fingerprint powder and the formulation of chemical reagents. The second stage involves processing the selected plant parts to produce fine powders or reagents, depending on the type of component chosen.
2. After the processing stage, a fine-grained powder will be produced following the methodology outlined by Sharma et al. (2024) and tested on various porous surfaces (such as paper, raw wood, fabric, cardboard, and concrete walls) and non-porous surfaces (such as glass, plastic, metal, and ceramic) during the trial phase to evaluate its effectiveness. The fineness and grain size will be ensured by adhering to the specifications provided in Sodhi and Kaur (2001). The most suitable powder will be the one that reveals fingerprint ridges with the highest clarity. Chemical reagents will be formulated using plant extracts, with careful consideration of sweat composition and its chemistry during the fingerprint development process.

3. The methodology for creating Suspension Particle Reagent (SPR) will follow the approach outlined by Bumbrah (2016), which emphasizes the critical importance of the suspension material and surfactant in the composition of aqueous SPR. The effectiveness, contrast, and quality of the developed fingerprints rely heavily on this composition. Therefore, the focus will be on formulating an optimal SPR to ensure the clear development of fingerprints.
4. Another methodology for fluorescent SPR, described by Sodhi and Kaur (2012), involves the use of chemicals and stains combined with a liquid surfactant. A suspension is created by mixing the stain and surfactant detergent with the chemical and distilled water, resulting in the formation of SPR that produces clear fingerprints. This approach will be referenced for developing alternative SPR formulations.

The present study will focus on utilizing bio-based resources for reagent preparation and powder formulation, aiming to create methods that are both easy to prepare and use, while minimizing the reliance on harsh chemicals.

LIMITATIONS OF THE STUDY

1. The study will be limited to a select range of plant species and plant parts rather than exploring the full spectrum of available plant varieties.
2. The cost-effectiveness of using unconventional materials for the preparation and development of powders and reagents remains uncertain. While efforts will be made to maintain affordability, there is no assurance that these methods will ultimately prove to be cost-effective.

FUTURE SCOPE OF STUDY

The potential implications of this research, which is focused on creating novel and sustainable methods for latent fingerprint generation, are enormous for the fields of forensic science and environmental sustainability. The requirement for ecologically conscious activities is growing in importance as forensic science develops. In addition to meeting this demand, the study on reducing the amount of chemicals used in latent fingerprint detection opens up new avenues for developments and uses in the industry.

1. **Adoption of Green Forensic Techniques:** There will probably be a global demand for green forensic techniques from law enforcement organizations as environmental sustainability becomes more and more of a concern. The adoption of these strategies may be facilitated by this study, which may result in new industry norms that give preference to renewable, biodegradable, and non-toxic materials over conventional chemical-based procedures.

2. **SDG 12: Plant-Based Fingerprint Technologies for a Greener Future:** The goal of this research is to help achieve SDG 12: Responsible Consumption and Production by investigating and improving these plant-based alternatives in the future. This would guarantee the creation of safe, reliable, and sustainable fingerprint detection techniques that complement international environmental and sustainability objectives.

3. **Enhanced Forensic Capabilities in Resource-Limited Environments:** Eco-friendly an inexpensive fingerprint creation technique may be especially helpful in environments with limited resources, such as those with restricted access to traditional forensic materials. Researchers may be able to improve the investigation capacities of forensic experts in underdeveloped countries by creating affordable methods that they can use.

4. **Benefits for Public Health and Safety:** In a study by Rabjerg et al. (1983), the effects of lead powder exposure were examined in 22 Danish police officers involved in fingerprint detection. Clinical assessments and blood lead analyses were conducted, revealing that while none showed signs of lead toxicity, their blood lead concentrations were significantly higher than the general population. A strong correlation ($r = 0.87$, $p < 0.0001$) was found between blood lead levels and weekly exposure. This highlights the need for safer alternatives in forensic practices to reduce reliance on hazardous substances and improve occupational safety in forensic labs and fieldwork.

5. **Integration with Forensic Curriculum:** The results of the study can be included into the teaching of forensic science, which will result in the creation of curricula that are specifically centered on environmentally friendly forensic procedures. This will guarantee that forensic scientists in the future have the know-how to apply ecologically friendly methods from the beginning of their careers.

6. **Development of New Forensic Products:** The design of new forensic goods that are environmentally benign and just as effective as or more so than current chemical-based techniques can be influenced by the research. The environmental impact of forensic investigations can be decreased by using alternative fingerprint powders, sprays, and other instruments that make use of synthetic or natural biodegradable materials.

In conclusion, this work has the potential to transform forensic science by presenting novel, sustainable methods for latent fingerprint production. The future scope includes a wide range of advantages, such as cross-disciplinary applications, worldwide environmental impact, and the widespread use of green forensic procedures. In addition to advancing forensic science, this study will support a larger scientific and technological drive toward sustainability.

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WORK PLAN | TIME LINES

Research Activity	6	12	18	24	30	36	*
1. Course Work							
2. Literature Survey							
3. Methodology Steps							
4. Quarterly Reports							
5. Communication of Papers							
6. Preparation of Final Thesis							
7. Submission of Thesis							

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REFERENCES

1. Badiye, A., Kapoor, N., 2015. Efficacy of Robin® powder blue for latent fingerprint development on various surfaces. Egyptian Journal of Forensic Sciences 5, 166–173.
2. Berry: David A. Stoney The history and development... - Google Scholar [WWW Document], 2024. URL https://scholar.google.com/scholar_lookup?&title=The%20history%20and%20development%20of%20fingerprinting&pages=1-38&publication_year=1991&author=Berry%2CJ. (accessed 8.30.24).
3. Bhoopesh Kumar Sharma, 2022. Fingerprint Science: A Review on Historical And Contemporary Forensic Perspectives. ©2022 Academy for Environment and Life Sciences, India 57–61.
4. Bumbrah, G.S., 2016. Small particle reagent (SPR) method for detection of latent fingermarks: a review. Egypt J Forensic Sci 6 (4): 328–332.
5. Chauhan, A., Udayakumar, K., 2017. Development of latent prints by using the unconventional methods on diverse façade. Int. J. Res. Eng. Appl. Sci. 7, 67–75.
6. Dhunna, A., Anand, S., Aggarwal, A., Agarwal, A., Verma, P., Singh, U., 2018. New visualization agents to reveal the hidden secrets of latent fingerprints. Egypt J Forensic Sci 8, 32. https://doi.org/10.1186/s41935-018-0063-9
7. Francisco M. Gomes a, Claudio Martin Pereira de Pereira b, Kristiane de Cássia Mariotti c d, Thieres Magaiver Pereira a, Nayara Araujo dos Santos a d, Wanderson Romão, 2023. Study of latent fingerprints – A review. Forensic Chemistry 35.
8. Gayatri Sarade*1, Shivani Patole*2, 2024. Innovations In Fingerprint Development Techniques – A Review. IRJMETS 6, 6712–6716.
9. Godara, V., Aseri, V., Lohar, S., Kumari, P., Mavry, B., Nagar, V., Singhal, A., Singh, A., Awasthi, K.K., Sankhla, M.S., 2022. Comparative Study Of Rose And Hibiscus Petals Powders In Latent Friction Ridge Analysis. Problems of Forensic Sciences/Z Zagadnien Nauk Sadowych.
10. Gomes, F.M., de Pereira, C.M.P., de Cássia Mariotti, K., Pereira, T.M., dos Santos, N.A., Romão, W., 2023. Study of latent fingerprints. Forensic Chemistry 100525.
11. Harshita Niranjan1, Shweta Rai1, Kapil Raikwar2, Chanchal Kamle2 and Rakesh Mia2*, 2024. Unconventional powder method is a useful technique to determine the latent fingerprint impressions. Journal of Forensic Science and Research. https://doi.org/10.29328/journal.jfsr.1001035
12. Jamal, F., 2019. Conventional Methods of Latent Fingerprint Development. Think India Journal 22, 1976–1983.
13. Jasuja, O.P., Singh, G.D., Sodhi, G.S., 2007. Development of Latent Fingerprints on the Sticky Side of Adhesive Tapes: Phase Transfer Catalyst-Based Formulation. Canadian Society of Forensic Science Journal 40, 1–13. https://doi.org/10.1080/00085030.2007.10757147
14. Kamble, D., Pandey, S., Kumari, A., Sharma, K., 2018. A new powder method for development of latent fingerprint, in: All India Forensic Science Conference.
15. Kapoor, N., Moon, P., Pardeshi, P., Badiye, A., 2023. Introduction to Fingerprints, in: Shrivastava, P., Lorente, J.A., Srivastava, A., Badiye, A., Kapoor, N. (Eds.), Textbook of Forensic Science. Springer Nature Singapore, Singapore, pp. 245–278. https://doi.org/10.1007/978-981-99-1377-0_8
16. Kaushal, N., Kaushal, P., 2011. Human identification and fingerprints: a review. J biomet biostat 2, 2.
17. Kerr, F.M., Barron, I.W., Haque, F., Westland, A.D., 1983a. Organic-Base Fluorescent Powders for Latent Fingerprint Detection on Smooth Surfaces: Part II. Canadian Society of Forensic Science Journal 16, 39–44.

https://doi.org/10.1080/00085030.1983.10756917
18. Kerr, F.M., Haque, F., Westland, A.D., 1983b. "Organic Based Powders for Fingerprint Detection on Smooth Surfaces": Part I. Canadian Society of Forensic Science Journal 16, 140–142. https://doi.org/10.1080/00085030.1983.10756931
19. Kriti Nigam1, Tanurup Das1, Abhimanyu Harshey1, Akash Kumar1, Neeti Kapoor2, Vijay K Yadav1 And Ankit Srivastava1, 2020. Effectiveness of Talcum Powder for Decipherment of Latent Fingerprints on Various Substrates. Asian Journal of Chemistry 33, 120–126.
20. Mishra, N.K., 2022. Fingerprint Science: A Review on Historical And Contemporary Forensic Perspectives.
21. Mr. Krunal N. Jariwala, 2024. Forensic Examination of Paint. Indian Journal Of Applied Research 4.
22. Neeti Kapoor, Poonam Moon, Pooja Pardeshi & Ashish Badiye, 2023. Introduction to Fingerprints. Springer, Singapore 245–278. https://doi.org/10.1007/978-981-99-1377-0_8
23. Niranjan, H., Rai, S., Raikwar, K., Kamle, C., Mia, R., 2022. Unconventional powder method is a useful technique to determine the latent fingerprint impressions.
24. Nitin Kaushal and Purnima Kaushal, 2011. Human Identification and Fingerprints: A Review. Journal of Biometrics & Biostatistics 2. https://doi.org/10.4172/2155-6180.1000123
25. Prashant Kumar1, Shubham Tyagi2, Nisha3, Kuldeep Sirav4, 2017. Recent Advancement in Development of Latent Fingerprints by Various Physical Methods: A Review. International Journal for Research in Applied Science & Engineering Technology (IJRASET) 5. https://doi.org/10.22214/ijraset.2017.10131
26. Rabjerg, L., Jennum, P.J., Mørck, H.I., 1983. White lead exposure among Danish police officers employed in fingerprint detection. Scandinavian journal of work, environment & health 511–513.
27. Rajeshkumar, S., n.d. A Technique For Visualisation Of Latent Fingerprint Using Spirulina Powder On Electronic Surfaces.
28. Rohatgi, R., Kapoor, A.K., 2014. New visualizing agents for developing latent fingerprints on various porous and non-porous surfaces using different household food items. Asian Journal of Science and Applied Technology 3, 33–38.
29. Sagar, S., Abirami Arthanari, D.R., 2022. Evaluation Of Latent Fingerprints Using Titanium Dioxide Powder And Herbal Powders On Different Surfaces-An Observational Study. Journal of Positive School Psychology 6, 993–998.
30. Sandra SagarSandra SagarAbirami ArthanariAbirami ArthanariRajeshkumar ShanmugamRajeshkumar ShanmugamPratibha RamaniPratibha Ramani, 2022. Evaluation Of Latent Fingerprints Using Titanium Dioxide Powder And Herbal Powders On Different Surfaces-An Observational Study. Journal of Positive School Psychology 6, 993–998.
31. Sankhla, M.S., 2018. Marble slurry powder are using visualization on latent fingerprints on different surfaces. Available at SSRN 3958673.
32. SeeratVaibhav SaranVaibhav SaranLav KesharwaniLav KesharwaniShow all 5 authorsMunish Kumar MishraMunish Kumar Mishra, 2015. Comparative Study Of Different Natural Products For The Development Of Latent Fingerprints On Non Porous Surfaces. IJournals: International Journal of Social Relevance & Concern (IJSRC) 3.
33. Sekar, M., Zulkifli, N.F., 2017. Development of natural latent fingerprint powder from durian seeds-a green and effective approach in crime scene. Indo American Journal of Pharmaceutical Sciences 4, 2362–2367.

34. Sharma, V., Rai, A.R., Jain, D., Kumari, P., Nagar, V., Singh, A., Awasthi, K.K., Gautam, A., Sharma, T., Sankhla, M.S., 2024. Exploring the Potential of Syzygium cumini (L.) Skeels (Jamun) Seed Powder as an Eco-Friendly Agent for Developing Friction Ridges on Porous and Nonporous Surfaces. Journal of Forensic Science and Medicine 10, 75–83.

35. Sneha Lohar a, Vinay Aseri a, Vanisha Godara a, Poonam Kumari a, Varad Nagar a, Pritam P. Pandit a, Rushikesh L. Chopade a, Apoorva Singh a, Kumud Kant Awasthi b, Mahipal Singh Sankhla a, Navjot Kaur c, Gaurav Kumar Singh, 2022. Comparative study of development of latent fingerprint by using cost effective waste materials. Materials Today: Proceedings 68, 848–853.

36. Sodhi, G.S., Kaur, J., 2012. A novel fluorescent small particle reagent for detecting latent fingerprints on wet non-porous items. Egyptian Journal of Forensic Sciences 2, 45–47.

37. Sodhi, G.S., Kaur, J., 2001. Powder method for detecting latent fingerprints: a review. Forensic science international 120, 172–176.

38. V JayaAbirami ArthanariAbirami ArthanariRajeshkumar ShanmugamRajeshkumar Shanmugam, 2021. A New Technique for visualisation of latent fingerprints in walls, floors and doors using Lodhra bark (Symplocos Racemosa). Type of article: Original study. Drugs and Cell Therapies in Hematology 10.

39. Wargacki, S.P., Lewis, L.A., Dadmun, M.D., 2008. Enhancing the Quality of Aged Latent Fingerprints Developed by Superglue Fuming: Loss and Replenishment of Initiator. Journal of Forensic Sciences 53, 1138–1144. https://doi.org/10.1111/j.1556-4029.2008.00822.x

40. Wargacki, S.P., Lewis, L.A., Dadmun, M.D., 2007. Understanding the Chemistry of the Development of Latent Fingerprints by Superglue Fuming. Journal of Forensic Sciences 52, 1057–1062. https://doi.org/10.1111/j.1556-4029.2007.00527.x

41. Win, K.N., Li, K., Chen, J., Viger, P.F. and Li, K., 2020. Fingerprint classification and identification algorithms for criminal investigation: A survey. Future Generation Computer Systems, 110, pp.758-771. - Search [WWW Document], 2024. URL https://www.bing.com/search?q=Win%2C+K.N.%2C+Li%2C+K.%2C+Chen%2C+J.%2C+Viger%2C+P.F.+and+Li%2C+K.%2C+2020.+Fingerprint+classification+and+identification+algorithms+for+criminal+investigation%3A+A+survey.+Future+Generation+Computer+Systems%2C+110%2C+pp.758-771.&cvid=ac2bf44cf9364e62af119b09054a1560&gs_lcrp=EgZjaHJvbWUyBggAEEUYOagCALACAA&FORM=ANAB01&PC=HCTS (accessed 8.30.24).

42. Win, K.N., Li, Kenli, Chen, J., Viger, P.F., Li, Keqin, 2020. Fingerprint classification and identification algorithms for criminal investigation: A survey. Future Generation Computer Systems 110, 758–771. N.d.